

*This program was written by Paul L. Luz of Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31796.*



## **Program Calculates Forces in Bolted Structural Joints**

A FORTRAN 77 computer program calculates forces in bolts in the joints of structures. This program is used in conjunction with the NASTRAN finite-element structural-analysis program. A mathematical model of a structure is first created by approximating its load-bearing members with representative finite elements, then NASTRAN calculates the forces and moments that each finite element contributes to grid points located throughout the structure. The user selects the finite elements that correspond to structural members that contribute loads to the joints of interest, and identifies the grid point nearest to each such joint. This program reads the pertinent NASTRAN output, combines the forces and moments from the contributing elements to determine the resultant force and moment acting at each proximate grid point, then transforms the forces and moments from these grid points to the centroids of the affected joints. Then the program uses these joint loads to obtain the axial and

shear forces in the individual bolts. The program identifies which bolts bear the greatest axial and/or shear loads. The program also performs a "fail-safe" analysis in which the foregoing calculations are repeated for a sequence of cases in which each fastener, in turn, is assumed not to transmit an axial force.

*This program was written by Daniel A. Buder of The Boeing Company for Johnson Space Center.*

*Title to this invention, covered by U.S. Patent No. 5,884,232 has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)). Inquiries concerning licenses for its commercial development should be addressed to:*

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*Refer to MSC-23121, volume and number of this NASA Tech Briefs issue, and the page number.*

- Automate repetitive processes in testing and analysis;
- Accelerate pre-test analysis;
- Accelerate reporting of tests;
- Facilitate planning of tests;
- Improve execution of tests;
- Create a vibration, acoustics, and shock test database; and
- Integrate analysis and test data.

The software package includes modules pertaining to sinusoidal and random vibration, shock and time replication, acoustics, base-driven modal survey, and mass properties and static/dynamic balance. The program is commanded by use of ActiveX controls. There is minimal need to generate command lines. Analysis or test files are selected by opening a Windows Explorer display. After selecting the desired input file, the program goes to a so-called analysis data process or test data process, depending on the type of input data. The status of the process is given by a Windows status bar, and when processing is complete, the data are reported in graphical, tubular, and matrix form.

*This work was done by Daniel Kaufman of Goddard Space Flight Center. Further information is contained in a TSP (see page 1).*

*This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center, (301) 286-7351. Refer to GSC-14775-1.*



## **Integrated Structural Analysis and Test Program**

An integrated structural-analysis and structure-testing computer program is being developed in order to: